Valve

A control valve regulates either flow or pressure in a distribution system. Valves are modeled as nodes in InfoWater Pro. Because Valves are link elements in our Analysis EPANET engine, valves are converted to node or point elements by creating hidden junctions to the left and right of the valve that you cannot see in InfoWater Pro, but can be seen in an EPANET export of the model. The elevation of the valve is used as the hidden node elevation and the valve upstream and downstream pressure are calculated from the pressure at the two hidden nodes.

Valve direction is surmised in InfoWater Pro by the direction of the two pipes connected to the valve. Both connected pipes to the valve should be drawn in the direction of expected flow through the valve.

How do I...

Create a Valve?

To create a Valve node:

Click on the **InfoWater Pro Ribbon** in the **Edit Group** using the **Insert Command dropbox**.

Select the **Insert Valve** icon from the **Insert Command dropbox**.

When the **Insert Valve** command is the active command it will be highlighted in Blue as shown: 

Once the command is initiated, select the location of the new node by left mouse clicking anywhere on the map display. Suggest a new ID and/or a description on the **Valve Identification** dialog box and click **OK** to accept the ID and create the new Valve. The Valve should visually appear at the specified location. If the insert location is near an existing model pipe, the software will prompt you to insert the Valve into that pipe. If you wish to split the pipe, the **Valve Identification** dialog box for the new Valve and the new pipe will appear in a pop-up window.

**Types of Valves?**

There are eight different valve types that can be used within InfoWater Pro. A discussion of each valve **Type** available and the data required for each type can be found below.

**Pressure Reducing Valves (PRV)** - A PRV limits the pressure on the downstream end not to exceed a pre-set value when the upstream pressure is above the setting. The PRV valve has three potential states the valve can be in: **Active, Open, or Closed**. The Valve is partially opened (i.e., **Active**) to achieve its pressure setting on its downstream side when the upstream pressure is above the setting, and will induce headloss to maintain the downstream pressure setting. The valve is fully **Open** if the upstream pressure is below the setting and will provide as much flow as the upstream head of the valve can provide. When Open the valve will essentially act like an open pipe. Should the pressure on the downstream (based on the valve elevation) exceed the setting of the valve, the valve is **Closed**. The valve will also be **Closed** if the pressure on the downstream side exceeds that on the upstream side (i.e., reverse flow is not allowed) to prevent reverse flow. A valve can also override it Status via the initial Status setting or by control to set the valve **Open or Closed**. If a PRV is set to **Open** it will act like an Open pipe. If a PRV is given a STATUS of **OFF**, a Valve **Setting** in a control statement is necessary to make it act like a valve. Specify the Valve Type as **Pressure Reducing** in the **Type** field of the **Modeling Data** section of the **Model Explorer - Attribute Tab**.

**Required Fields:**

- **Elevation** - Specify the elevation of the valve in ft (m).
- **Diameter** - Enter the diameter of the valve in this field, in (mm).
- **Setting** - Downstream pressure setting, psi (m).

**Optional Fields:**

- **Minor Loss** - Minor loss coefficient, \( K \) InfoWater Pro will calculate the minor loss as \( K \sqrt{V^2/g} \) where \( K \) is the minor loss coefficient, \( V \) is the **Velocity**, and \( g \) is the gravitational constant. This field is optional, but recommended to be used to limit the maximum allowed flow through the valve. Most PRV valves generally have a \( K \) in the 4-6 range. A specific \( K \) for a valve can usually be identified from manufacturer data using the actual size of the valve.

For **PRVs please do not** enter any data to the **Curve**, **PID**, **UCL**, or **LCL** fields.
Pressure Sustaining Valves (PSV) - A PSV maintains a minimum pressure on its upstream end when the downstream pressure is below the recommended to be used to limit the maximum allowed flow through the valve. If a PSV is set to Open or Closed, it will act like an Open pipe. If a PSV is given a STATUS of Off, a Valve Setting in a control statement is necessary to make it act like a valve. If the downstream pressure is above the setting, then flow through the valve is unrestricted. Should the downstream pressure exceed the pressure upstream pressure, then the valve closes to prevent reverse flow. Specify the Valve Type as Pressure Sustaining in the Type field of the Modeling Data section of the Model Explorer - Attribute Tab.

Required Fields:

- **Elevation** - Specify the elevation of the valve in ft(m).
- **Diameter** - Enter the diameter of the valve in this field, in (mm).
- **Setting** - Upstream pressure setting, psi (m).

Optional Fields:

- **Minor Loss** - Minor loss coefficient, \( K \). InfoWater Pro will calculate the minor loss as \( K(V^2)/2g \) where \( K \) is the minor loss coefficient, \( V \) is the Velocity, and \( g \) is the gravitational constant. This field is optional, but recommended to be used to limit the maximum allowed flow through the valve. Most PRV valves generally have a \( K \) in the 4-6 range. A specific \( K \) for a valve can usually be identified from manufacturer data using the actual size of the valve.

For PSVs please do not enter any data to the Curve, PID, UCL, or LCL fields.

Pressure Breaker Valves (PBV) - PBV's may be used to force a specified pressure loss to occur across the valve. PBVs do not really exist in the field. They are an abstraction to help model unaccountable pressure losses in the system. Flow can be in either direction through the valve. Specify the Valve Type as Pressure Breaker in the Type field of the Modeling Data section of the Model Explorer - Attribute Tab.

Required Fields:

- **Elevation** - Specify the elevation of the valve in ft(m).
- **Diameter** - Enter the diameter of the valve in this field, in (mm).
- **Setting** - Upstream pressure setting, psi (m).

Optional Fields:

- **Minor Loss** - Minor loss coefficient, \( K \). InfoWater Pro will calculate the minor loss as \( K(V^2)/2g \) where \( K \) is the minor loss coefficient, \( V \) is the Velocity, and \( g \) is the gravitational constant. This field is optional, but recommended to be used to limit the maximum allowed flow through the valve. Most PRV valves generally have a \( K \) in the 4-6 range. A specific \( K \) for a valve can usually be identified from manufacturer data using the actual size of the valve.

For PBVs please do not enter any data to the Curve, PID, UCL, or LCL fields.

Flow Control Valves (FCV) - Flow Control Valves limit the flow through a valve to a specified value based on the active setting for the valve. The program produces a warning message if this the head necessary to push the specified flow cannot be provided based on the available head upstream of the valve or if the valve has reverse flow. An error of “Open but cannot deliver flow” for a FCV indicates the upstream pressure is insufficient to push the specified setting flow into the system. Specify the Valve Type as Flow Control in the Type field of the Modeling Data section of the Model Explorer - Attribute Tab. Please Note that FCV will allow reverse flow if the downstream head exceeds the head upstream of the valve, but will cause an Warning Message to be generated.

- **Elevation** - Specify the elevation of the valve in ft(m).
- **Diameter** - Enter the diameter of the valve in this field, in (mm).
- **Setting** - Design flow (through valve), flow units gpm (L/s).

Optional Fields:

- **Minor Loss** - Minor loss coefficient, \( K \). InfoWater Pro will calculate the minor loss as \( K(V^2)/2g \) where \( K \) is the minor loss coefficient, \( V \) is the Velocity, and \( g \) is the gravitational constant. This field is optional, but recommended to be used to limit the maximum allowed flow through the valve. Most PRV valves generally have a \( K \) in the 4-6 range. A specific \( K \) for a valve can usually be identified from manufacturer data using the actual size of the valve. Note: Minor Loss values are ignored by EPANET for FCV's until the valve status is set to Open. You may wish to assign the FCV minor loss to the upstream pipe connected to the valve to limit the maximum flow through the valve. If the Minor Loss value is assigned to the upstream pipe, do not also include a minor loss value for the FCV or you may inadvertently double the total minor loss headloss.

For FCVs, do not enter any data into the Curve, PID, UCL, or LCL fields.
Throttle Control Valves (TCV) - A TCV may be used to simulate a partially opened valve by adjusting the minor loss coefficient. They are normally used to increase or decrease flows or to control pressures in the system. A TCV is the best valve to use for modeling normally open system valves as a valve in InfoWater Pro. A TCV can either have a Minor Loss vs. %Open curve associated with it or not. Whether a curve is associated or not depends on what the Setting value means to InfoWater Pro. TCV valves will also allow reverse flow through the valve. To fully close a TCV, assign a valve status of CLOSED as a zero setting for a TCV will not ensure zero flow. Please be aware the multiple GPV's in any pipeline loop may cause difficulties in the EPANET engine to solve. Specify the Valve Type as Throttle Control in the Type field of the Modeling Data section of the Model Explorer - Attribute Tab.

Required Fields:

- **Elevation** - Specify the elevation of the valve in ft(m). Necessary to correctly calculate the upstream and downstream pressure.
- **Setting** - %Open (with curve identified), K value (no curve).
- **Diameter** - Diameter of valve, in. (mm).
- **Curve (Optional)** - Minor Loss vs. %Open Curve ID.

Optional Fields:

- **Minor Loss** - Minor loss coefficient, $K$. InfoWater Pro will calculate the minor loss as $K(V^2)/2g$ where $K$ is the minor loss coefficient, $V$ is the velocity, and $g$ is the gravitational constant. This field is optional, but recommended to be used to limit the maximum allowed flow through the valve. Most PRV valves generally have a $K$ in the 4-6 range. A specific $K$ for a valve can usually be identified from manufacturer data using the actual size of the valve.

For TCVs please do not enter any data to the PID, UCL, or LCL fields.

Minor Loss vs. % Open (Control Valves - Motorized Throttled) Curves for Throttle Control Valves

A relationship between the degree (or percentage) to which a valve is closed and the resulting headloss coefficient is usually available from the valve manufacturer or can be derived from field tests (based on measured flow through the valve, headloss across the valve and percentage (degree) opening setting). Alternatively, a curve can be used to define the relationship between valve openings and loss coefficients. In this case, the $\lambda$ values represent the percentage (degree) opening settings and the $K$ values designate the resulting headloss coefficients. Based on the valve opening settings specified, loss coefficients are directly computed by InfoWater Pro for linearly interpolated values of intermediate percentage (degree) opening settings. When such a curve is used, this type of valves is also referred to as Motorized Throttled Valves (MTV). For Motorized Throttled Valves (MTVs), a Minor Loss Coefficient Curve consists of a collection of points defining the minor loss coefficient $K(y$-axis) as a function of the percentage (degree) opening setting (x-axis). It provides the capability to model valves with unique headloss characteristics such as cone and butterfly valves. Please limit the maximum minor loss value assigned to the valve to be under 100,000 as higher minor loss values can cause difficulties for EPANET to use. A sample table and curve are provided below:

<table>
<thead>
<tr>
<th>Open (%)</th>
<th>Minor Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>1</td>
<td>1.00</td>
</tr>
<tr>
<td>2</td>
<td>2.50</td>
</tr>
<tr>
<td>3</td>
<td>10.00</td>
</tr>
<tr>
<td>4</td>
<td>12.00</td>
</tr>
<tr>
<td>5</td>
<td>15.00</td>
</tr>
<tr>
<td>6</td>
<td>20.00</td>
</tr>
<tr>
<td>7</td>
<td>23.00</td>
</tr>
<tr>
<td>8</td>
<td>25.00</td>
</tr>
<tr>
<td>9</td>
<td>28.00</td>
</tr>
</tbody>
</table>

General Purpose Valves (GPV) - General Purpose valves are used to represent cases where you define the headloss through the valve as a function of the flow. The GPV requires the assignment of the Headloss vs. Flow curve. A GPV may be used to model turbines, well draw-down or reduced-flow backflow prevention valves. This relationship is defined using a curve. If you have two GPV's in series, please combine the headloss for both valves into a single valve to avoid difficulties. Due to this limitation we do not recommend using GPV valves to represent normally open Valves models as a Valve in InfoWater Pro. One other Note GPVs due to their definition cannot be made active via a control statement. If you need to make a GPV active or inactive simply close one of the pipes connected to the GPV by controls. Specify the Valve Type as General Purpose in the Type field of the Modeling Data section of the Model Explorer - Attribute Tab.

Required Fields:

- **Elevation** - Specify the elevation of the valve in ft(m). Necessary to correctly calculate the upstream and downstream pressure.
- **Setting** - %Open (with curve identified), $K$ value (no curve).
• **Diameter** - Diameter of valve, in. (mm).
• **Curve** - Select the curve ID that represents the GPV curve of the type of headloss vs. flow.

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**Headloss vs. Flow (Control Valves - General Purpose, Float) Curves for General Purpose Valves and Float Valves**

Used for General Purpose Valves and Float Valves, the curve consists of a collection of points defining the headloss across the valve (y-axis) and flow rate in flow units (x-axis). A sample table and curve are provided below:

<table>
<thead>
<tr>
<th>Curve Type</th>
<th>Flow (gpm)</th>
<th>Headloss (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.00</td>
<td>2.00</td>
</tr>
<tr>
<td>2</td>
<td>1200.00</td>
<td>4.00</td>
</tr>
<tr>
<td>3</td>
<td>2200.00</td>
<td>6.00</td>
</tr>
<tr>
<td>4</td>
<td>3000.00</td>
<td>8.00</td>
</tr>
<tr>
<td>5</td>
<td>3550.00</td>
<td>10.00</td>
</tr>
<tr>
<td>6</td>
<td>4000.00</td>
<td>12.00</td>
</tr>
</tbody>
</table>

**Float Valves** - Many storage tanks and reservoirs are fitted with float valves (e.g., ball float valves) on the inlet pipe to control rate of flow and prevent overflow. These valves gradually close (increase the resistance of the inlet pipe) as the water level in the controlling tank rises. The headloss across the valve is modeled (via a curve) based on any user specified pairs of Headloss vs. Flow points. The valve is active if the water level in the controlling tank is below the lower control level or the water level is between the lower and upper levels after the valve opens. Likewise, the valve is closed if the water level in the controlling tank is at or above the upper control level or the water level is between the lower and upper after the valve closes. Float valves are not an EPANET valve type, but are essentially a GPV with a control statement on one of the pipes connected to the valve. Specify the Valve Type as **Float** in the setting of the Model Explorer - Attribute Tab.

• **Diameter** - Diameter of valve, in. (mm).
• **Elevation** - Specify the elevation of the valve in ft (m). Necessary to correctly calculate the upstream and downstream pressure.
• **Curve** - Select the curve ID that represents the Float Valve headloss vs. flow.
• **PID** - The tank whose levels dictate the behavior of the Float Valve.
• **LCL** - The low "turn-on" level of the tank.
• **UCL** - The high "turn-off" level of the tank.

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**Vacuum Breaker Valves** - Vacuum breaker valves (VBV) are devices that allow air to enter at that location in the system when the pressure drops to atmospheric level. When the pressure drops to zero, the valve becomes active and will compute the correct flow rate required to maintain atmospheric condition. NOTE: VBV's may cause difficulties if locations downstream of the valve must receive water through the VBV type valve. VCBs are best used on dead ends to avoid creating a disconnected node warning when the valve closes. Specify the Valve Type as **Vacuum Breaker Valve** in the Type field of the Modeling Data section of the Model Explorer - Attribute Tab.

**Required Fields:**

• **Elevation** - Specify the elevation of the valve in ft (m). Necessary to correctly calculate the upstream and downstream pressure.
• **Diameter** - Diameter of valve, in. (mm)

**Other Types of Valves (Assigned Directly to Pipe Element)**
Check Valves - A valve located on a pipe that allows flow in one direction only. InfoWater Pro assumes that flow through pipes containing check valves is limited to the direction of the pipe (i.e., from the From-node U/S to the To-node D/S orientation). To add a check valve to a pipe, click on the pipe using the selection tool and from the Model Explorer - Attribute Tab, set Check Valve = Yes. All pipes containing Check Valves can be highlighted from the Domain Manager dialog box using the Special Query Element Source and selecting "Pipes" and "Check Valves".

Flow Totalizers- A meter located on a pipe that measures the cumulative bi-directional flow volume (ML or MG) through the pipe. If a flow totalizer is specified for a pipe, the Total Forward and Total Reverse fields on pipe reports will be populated. For pipes without flow totalizers, these fields will not be populated. InfoWater Pro will calculate and report the total flow volume in the forward and reverse direction (if flow reversal occurred) and the net flow volume.

To add a flow totalizer to a pipe, select the pipe and in the Model Explorer - Attribute Tab under the Modeling Data section, set Flow Totalizer = Yes. Pipes containing flow totalizers are displayed in a similar fashion to those not containing flow totalizers. All pipes containing flow totalizers can be highlighted from the Domain Manager dialog box using the Special Query Element Source and selecting Pipes and Flow Totalizers.

PSV/PRV Combined

- Deactivate the combo valve imported from GIS.
- Digitize two valves in series with the PSV upstream and the PRV downstream.
- Digitize a junction in between the two valves.
- Digitize a very small diameter "jumper" pipe across the PSV to transmit the correct upstream head information to the PRV (small diameter allows an insignificant amount of extra flow through when PSV is active).
- No simple or rule based controls are needed.

To represent a static valve (e.g., gate valve), a minor loss can be assigned to a pipe. Valves represent a loss element that is used to throttle or control the flow through the element. To isolate or close an element to flow, use the Facility Manager to activate and inactivate elements.

Edit a Valve?

Graphic Selection - To select a Valve node for data edit do one of the following:

Choose the Select icon from the Model Explorer - Attribute Tab window, and click on the specific Valve or select the InfoWater Pro Ribbon in the Edit Group using the Select icon.

If a Valve has been prior selected and is a part of the Browse history, it can be re-selected by choosing it from the Browse-History section of the Model Explorer - Attribute Tab window.

<table>
<thead>
<tr>
<th>VALVE: 300, Zone 2 Valve</th>
</tr>
</thead>
<tbody>
<tr>
<td>VALVE: 300, Zone 2 Valve</td>
</tr>
<tr>
<td>VALVE: V8006, New Valve</td>
</tr>
<tr>
<td>VALVE: V8004, New Valve</td>
</tr>
<tr>
<td>VALVE: V8002, New Valve</td>
</tr>
</tbody>
</table>
Data Edit - To edit the data related to a Valve, first select the Valve using the tools above. Once selected, edit Junction related data by adding/modifying the fields in the Model Explorer - Attribute Tab window. Additionally, modifications may be done by editing the DB Tables that may be accessed from the InfoWater Pro Ribbon in the Edit Group using the DB Editor icon.

Graphic Edit - To edit the node graphically do one of the following: From the InfoWater Pro Ribbon in the Edit Group using the Edit Command dropbox icon, select the Move Node command from the dropdown. Left click on the mouse and hold the left click down on the junction to select it. With the junction highlighted, move the node to the desired position while keeping the left click mouse button depressed. Once in the desired location, release the left mouse button and the node location will be updated to the new location.

When the Move Node command in the InfoWater Pro Ribbon in the Edit Group Edit Command dropbox is the active command it will be highlighted in Blue as shown:

If you have enabled Auto Length Calculation checkbox from the InfoWater Pro Ribbon in the Project Group using the Preferences icon and the Operations tab, all pipes connected to a node moved will not have their lengths automatically changed.

Edit the Data for a Group of Valves?

Group edits can be made by either creating a domain or by creating a selection.

Using the Domain Manager - Create a domain selecting the specific Valves that you want to edit. Refer to the section on Domain Manager for details on the domain creation process. Once the domain has been created, choose the InfoWater Pro Ribbon in the Edit Group using the DB Editor icon. Depending on the data you want to edit, choose the appropriate table type from among the different database tables. Choose as the Data Scope and click OK.

Using the User Selection - Select choose the InfoWater Pro Ribbon in the Edit Group using the DB Editor icon. Depending on the data you want to edit, choose the appropriate table type from among the different database tables. Choose as the Data Scope and choose the User Selection command. This places the software in User Selection Mode. In InfoWater Pro, the selected elements will be in a cyan color. Once all of the desired Valves are selected, right click and choose Enter to access the DB Tables for the selected Valves.

Once the specific tables have been opened with the desired scope, enter data one cell at a time or Block Edit data to make changes in bulk to multiple cells.

Delete a Valve?

To delete a Valve, select the Delete Node option in the InfoWater Pro Ribbon in the Edit Group Edit Command dropbox. Select the node to be deleted and InfoWater Pro prompts you to confirm deletion if the Delete Confirmation checkbox is checked in the Operation Settings tab in the Preferences settings.

The active selected Valve in the Model Explorer - Attribute Tab window may also be deleted by selecting the Delete icon with the InfoWater Pro prompt to confirm element deletion.
Recall a Deleted Valve?

To recall a deleted Valve, go to **Model Explorer - Command Center Tab** under **Utilities -> Recall** and select the **Node** command. In order to perform the recall, you must know the ID of the Valve that was deleted. You may choose the **Show Deleted Node** command to obtain a list of nodes deleted from the InfoWater Pro project but saved in the InfoWater Pro recycle bin. Deleted elements can be recalled until the **Pack** and then **Clean** commands (found in the **Model Explorer - Command Center Tab** under **Utilities - Database** menu list) are completed which removes deleted element ID’s from the database.

Important Rules for Valves

- Control Valves cannot be directly connected to check valves.
- Pressure settings for valves are pressures and not total head (or hydraulic grade line elevation).
- Setting a Valve status to Open in the Initial Status or via a control statement will make the valve act like an Open Pipe.